GRADE 12 DIPLOMA EXAMINATION

Physics 30

January 1984

Alberta
EDUCATION

GRADE 12 DIPLOMA EXAMINATION
PHYSICS 30

DESCRIPTION

Time: 2.5 hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination. A physics data booklet is provided for your reference. Approved calculators may be used.

GENERAL INSTRUCTIONS

There are 55 multiple-choice questions and three written-response questions on this examination.

For multiple-choice questions, read each carefully and decide which of the choices best completes the statement or answers the question. Locate that question on the answer sheet and fill in the space that corresponds to your choice. Use an HB pencil only.

Example

This examination is for the subject area of

A. Chemistry
B. Biology
C. Physics
D. English

Answer Sheet

A	B	C	D
○	○	●	○

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read carefully and write your answer in the space provided.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET.

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JANUARY 1984

1. A cyan-colored filter will only pass green and blue light; a yellow filter will only pass red, yellow, and green light. If a cyan and a yellow filter are placed in front of a white light source and the result is projected onto a movie screen, then the color on the screen is

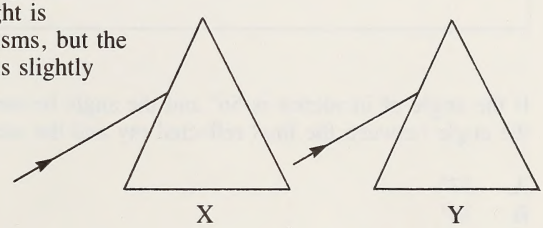
   A. reddish-blue
   B. white
   C. black
   D. green

2. If the angle between a plane mirror and an incident ray is 20°, then the angle between the incident ray and the reflected ray is

   A. 140°
   B. 70°
   C. 40°
   D. 20°

Use the following information to answer question 3.

The diagram to the right illustrates white light passing through two prisms. The speed of red light is the same in both prisms, but the speed of blue light is slightly less in X than in Y.



3. The observed spectra appear

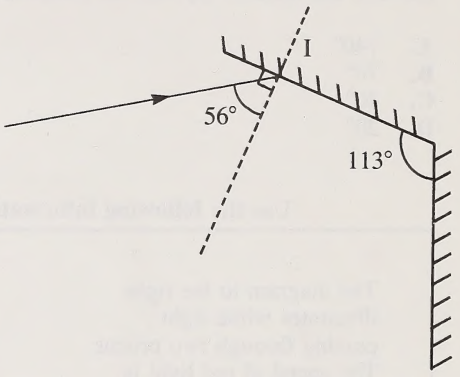
   A. the same size but with more colors for Y
   B. the same size for both prisms
   C. wider for X than for Y
   D. wider for Y than for X

4. When light goes from air into water, the

A. frequency increases
B. speed increases
C. frequency decreases
D. wavelength decreases

Use the following information to answer question 5.

In the diagram to the right, a ray of light hits the first mirror at point I and is reflected to the second mirror, where it is reflected again.



5. If the angle of incidence is 56° and the angle between the mirrors is 113°, then the angle between the final reflected ray and the second mirror is

A. 57°
B. 34°
C. 33°
D. 11°

---

6. A beam of monochromatic light passes through two slits, producing an interference pattern. If the slit separation is halved, the distance between adjacent fringes will be

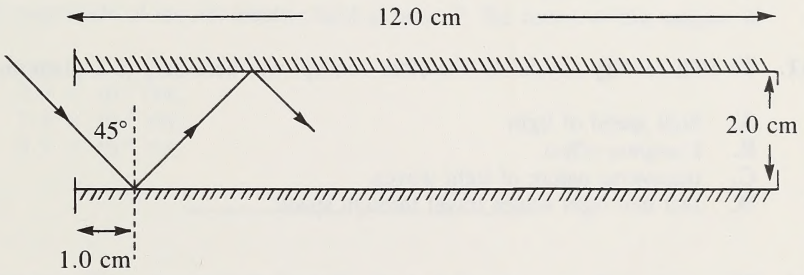
A. halved
B. quadrupled
C. doubled
D. unchanged

7. Römer gathered data to measure the speed of light by observing

A. lantern flashes on distant hills
B. the movement of Jupiter's moons
C. light radiated by the sun
D. light reflected from an octagonal mirror

Use the following information to answer question 8.

A beam of light is incident on one of a set of parallel mirrors as shown below.



8. Including the reflections indicated in the diagram, the final reflected ray occurs after

A. seven reflections, and its direction is upwards
B. three reflections, and its direction is downwards
C. five reflections, and its direction is upwards
D. six reflections, and its direction is downwards

9. Monochromatic light passes through two narrow slits that are 2.0×10^{-6} m apart and is projected on a screen 1.0 m away. If the light produces a first-order bright fringe 2.0×10^{-1} m from the centre of the interference pattern, the wavelength of the light is

A. 4.0×10^{-8} m
B. 4.0×10^{-7} m
C. 4.0×10^{-5} m
D. 4.0×10^{-4} m

10. The phenomenon of polarization can best be explained by considering light to behave as a

A. quantum
B. photon
C. longitudinal wave
D. transverse wave

11. To 19th-century physicists, the ether concept was necessary to explain the

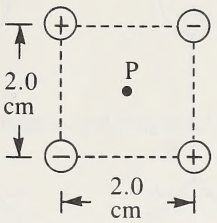
A. high speed of light
B. Compton effect
C. transverse nature of light waves
D. fact that light waves travel through space

12. The number of excess electrons that must be collected on a sphere to give it a charge of -5.6×10^{-6} C is

A. 9.0×10^{-25} e^-
B. 2.9×10^{-14} e^-
C. 3.5×10^{13} e^-
D. 2.9×10^{14} e^-

Use the following information to answer question 13.

In the diagram to the right, two protons and two electrons are arranged on the corners of a square.



13. The magnitude of the net electric field at point P, the centre of this square, is

A. zero
B. 2.0×10^{-5} N/C
C. 2.8×10^{-5} N/C
D. 5.7×10^{-6} N/C

---

14. When iron filings are used to show the lines of force about a bar magnet, each of the filings becomes

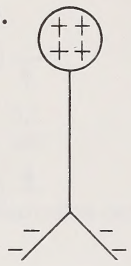
A. a permanent magnet
B. an electromagnet
C. a temporary magnet
D. a magnetic pole

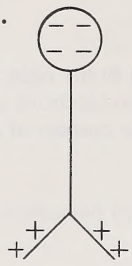
15. The net amount of charge contained within a closed system

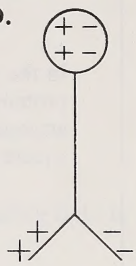
A. remains constant regardless of the influence on the system
B. may be increased or decreased by the influence of de Broglie waves
C. may be increased by the induction of a positive charge on the system
D. may be increased by the induction of a negative charge on the system

16. When a positively charged object is brought near the head of an initially uncharged electroscope, the diagram that best describes the state of the electroscope is

A. 

B. 

C. 

D. 

17. If a proton is accelerated through a one megavolt potential difference, it attains a speed of

A. 1.4×10^4 m/s
B. 1.4×10^7 m/s
C. 1.9×10^7 m/s
D. 1.9×10^{14} m/s

18. Charged particles with varying speeds enter a region having an electric field E and magnetic field $B = 5.0$ T. When $\vec{v}$, $\vec{B}$ and $\vec{E}$ are perpendicular to each other, the electric field required to permit the undeflected passage of only the particles with speed 2.0×10^5 m/s is

A. 1.6×10^{-13} N/C
B. 2.5×10^{-5} N/C
C. 4.0×10^4 N/C
D. 1.0×10^6 N/C

19. An electric field of 4.4×10^2 N/C exists between two large metal plates that are 40.0 cm apart. The potential difference between the plates is

A. 1.8×10^4 V
B. 1.1×10^3 V
C. 1.8×10^2 V
D. 1.1×10^2 V

20. The force between two current-carrying conductors provides the basis for the definition of

A. a coulomb
B. a volt
C. an ampere
D. an ohm

21. The force of deflection experienced by a moving charged particle in a uniform magnetic field is independent of the

A. charge of the particle
B. mass of the particle
C. particle's velocity
D. magnetic field strength

22. The first evidence of a connection between electrostatic and magnetic phenomena came from a series of experiments performed by

A. Oersted
B. Volta
C. Ampère
D. Franklin

23. A proton moving at 2.0×10^5 m/s perpendicularly to a magnetic field of 1.0 T experiences a deflecting force that causes it to orbit in a circle. The radius of the orbit is

A. 5.8×10^{-1} m
B. 2.1×10^{-3} m
C. 1.7×10^{-7} m
D. 3.2×10^{-10} m

24. The unit V/m is equivalent to a

A. N/C
B. C/N
C. C/J
D. J/C

25. An instrument used to detect the presence and nature of an electric charge is

A. an electroscope
B. an ammeter
C. a voltmeter
D. a galvanometer

26. Maxwell proposed that an electric field that is changing with respect to time generates a

A. direct current
B. uniform current
C. changing magnetic field
D. permanent magnetic field

27. The approximate range of frequencies of FM radio waves is 50 MHz to 500 MHz. A possible wavelength of an FM radio wave is

A. 3 km
B. 3 m
C. 3 cm
D. 3 mm

28. Red light having a wavelength of 7.0×10^{-7} m has a frequency of

A. 2.3×10^{-15} Hz
B. 2.1×10^{-14} Hz
C. 2.1×10^{2} Hz
D. 4.3×10^{14} Hz

29. Infra-red rays can penetrate smoky haze dense enough to block visible light because

A. scattering is much less for long wavelengths
B. scattering is much less for short wavelengths
C. infra-red rays have a higher frequency
D. infra-red rays have a shorter wavelength

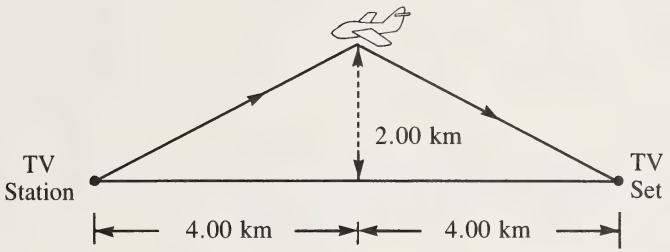
30. A collapsing magnetic field must produce

A. an electric field
B. a concentrated electric charge
C. a conducting region in space
D. accelerated charges

31. The wave nature of X-rays is demonstrated by their ability to

A. be diffracted by crystalline solids
B. penetrate many solids
C. ionize air molecules
D. be produced by Crookes' tube

Use the following information to answer question 32.



A TV set receives a signal by direct transmission and by reflection from a plane.

32. The time delay between the direct signal and the reflected signal is

A. 1.25×10^{-5} s
B. 6.30×10^{-6} s
C. 3.15×10^{-6} s
D. 1.58×10^{-6} s

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33. Electromagnetic waves having a period of 1.0×10^{-24} s are best classified as

A. radio rays
B. gamma rays
C. ultraviolet rays
D. infra-red rays

34. When the wave receiver in Hertz's experiment is rotated through 90°, a spark is no longer produced. This shows that electromagnetic waves can be

A. absorbed
B. diffracted
C. reflected
D. polarized

35. A radio station broadcasts on a wavelength of 5.0×10^2 m. What is the frequency of the station's radio waves?

A. 1.7×10^{-6} Hz
B. 6.0×10^5 Hz
C. 3.0×10^8 Hz
D. 1.5×10^{11} Hz

36. Maxwell's inference that ''light consists in the transverse undulations of the same medium which is the cause of electric and magnetic phenomena'' was based on the discovery that light and other electromagnetic waves

A. can be reflected
B. have the same frequency range
C. have very nearly the same speed
D. travel in straight lines

37. When zinc ($W = 4.0$ eV) in a photoelectric cell is irradiated by radiation of frequency 4.5×10^{15} Hz, the maximum kinetic energy of photoelectrons leaving the cell is

A. 3.7×10^{-18} J
B. 3.0×10^{-18} J
C. 2.3×10^{-18} J
D. 6.4×10^{-19} J

38. The energy of a blue photon with a wavelength of 4.0×10^{-7} m is

A. 8.8×10^{-49} J
B. 2.6×10^{-41} J
C. 1.7×10^{-27} J
D. 5.0×10^{-19} J

39. An electron with kinetic energy 4.9 eV collides with an atom at ground state. The second energy level of the atom is 4.1 eV above its ground state. If after collision the atom is in its first excited state, the final energy of the electron is

A. 0.4 eV
B. 0.8 eV
C. 4.1 eV
D. 9.0 eV

40. An electron drops from the 5th energy level ($E_5 = -8.7 \times 10^{-20}$ J) to the 2nd energy level ($E_2 = -5.4 \times 10^{-19}$ J) within an excited hydrogen atom. The frequency of the photon emitted is

A. 4.8×10^{14} Hz
B. 6.8×10^{14} Hz
C. 8.2×10^{14} Hz
D. 9.6×10^{14} Hz

41. By varying the electric and magnetic fields surrounding a cathode ray tube, Thomson

A. calculated the charge of an electron
B. determined the mass of the particles composing the cathode ray
C. calculated the value of the charge-to-mass ratio of the particles composing the ray
D. determined accurately the value of the proportionality constant in Coulomb's law

Use the following information to answer question 42.

Energies of some of the stationary states of hydrogen

$n = \infty$	0.0 eV
•	•
•	•
•	•
$n = 4$	$^{-}$0.8 eV
$n = 3$	$^{-}$1.5 eV
$n = 2$	$^{-}$3.4 eV
$n = 1$	$^{-}$13.6 eV

42. An electron makes a transition from $n = 4$ to $n = 2$. The wavelength of the corresponding spectral line is

A. 7.7×10^{-7} m
B. 6.7×10^{-7} m
C. 5.7×10^{-7} m
D. 4.8×10^{-7} m

43. On the basis of experimental evidence, Dalton hypothesized that

A. atoms consist of electrons, protons, and neutrons
B. chemical elements differ from one another because of different electrical structures
C. there are as many different types of atoms as there are chemical elements
D. in the production of compounds from atoms, matter is conserved

44. The mass of an element released during electrolysis is directly proportional to the

A. valence of the element
B. amount of charge passed through the solution
C. volume of the solution
D. atomic number of the element

45. Bohr explained the phenomena of the hydrogen spectrum by hypothesizing that

A. electrons have angular momentums corresponding to the energies of light observed in the spectrum
B. the wavelengths of light observed in the spectrum correspond to the radii of the allowable orbitals of the atom
C. discrete frequencies of light are emitted when a transition between two allowable energy states of the atom takes place
D. the electric influence of the electrons interacting with the magnetic influence of the nucleus produces electromagnetic waves corresponding to the frequencies of the observed spectrum

46. In Millikan's oil drop experiment, a charged particle having a mass of 6.4×10^{-16} kg is accelerating upwards at 2.2 m/s^2 under the influence of an electric field between two horizontal plates having a separation of 5.0 cm. If the potential difference across the plates is 120 V, the charge on the particle is

A. 5.9×10^{-19} C
B. 2.0×10^{-18} C
C. 3.2×10^{-18} C
D. 5.9×10^{-17} C

Use the following information to answer question 47.

Two hypotheses relating to an atomic model in which electrons orbit a nucleus are:

I Electrons lose energy and fall into the nucleus.
II Electrons emit radiation continually.

47. According to quantum theory, which of the following should occur?

A. Neither I nor II
B. Both I and II
C. Only I
D. Only II

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48. The momentum of a photon of light with a wavelength of 5.0×10^{-7} m is

A. 1.5×10^{2} kg•m/s
B. 1.6×10^{-15} kg•m/s
C. 1.3×10^{-27} kg•m/s
D. 3.3×10^{-40} kg•m/s

49. As the speed of an electron increases, its charge-to-mass ratio becomes

A. variable
B. invariant
C. larger
D. smaller

50. The Schrödinger equation is used to calculate

A. whether a standing wave will form
B. the work function of a metallic element
C. the probability of locating an atomic particle at a given place and time
D. whether it is easier to analyze a situation by wave mechanics or particle theory

51. If a proton's relativistic mass is 2.1×10^{-27} kg, its speed is

A. 1.9×10^{8} m/s
B. 1.8×10^{8} m/s
C. 1.3×10^{8} m/s
D. 1.1×10^{8} m/s

52. The de Broglie wavelength of an electron travelling at a speed of 5.0×10^6 m/s is

A. 2.0×10^{-7} m
B. 1.5×10^{-10} m
C. 5.8×10^{-17} m
D. 2.1×10^{-18} m

53. The total mass of a moving object is the sum of its

A. rest mass and mass increase
B. rest mass and relativistic mass
C. relativistic mass and mass increase
D. relativistic mass and energy equivalent

54. The reduction in frequency of some X-rays as they pass through a thin metal foil (the Compton effect) confirms that

A. the wavelength of electrons is equal to h/mv
B. light quanta have momentum but no rest mass
C. light is affected by gravitational fields
D. light is affected by electric fields

55. The idea that it is impossible to measure both the position and velocity of an electron to unlimited accuracy was proposed by

A. Compton
B. Schrödinger
C. de Broglie
D. Heisenberg

THANK YOU FOR COMPLETING THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION.
PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

WRITTEN RESPONSE

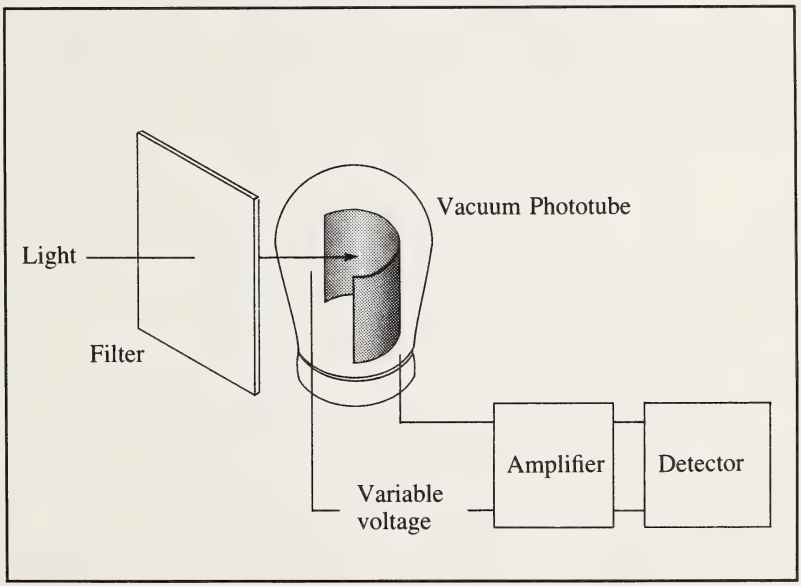
INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

Show all pertinent calculations and formulas, and give your answers to the correct number of significant figures.

(USE FOR ROUGH WORK ONLY)

1. Two student groups used a photoelectric cell and color filters to determine the stopping voltage for three colors of light. Sunlight was allowed to fall directly on the cell and the voltage required just to stop the flow of electrons was determined. Each of the three color filters was then placed in succession over the cell, and stopping voltages were determined. A diagram of the apparatus used and the results recorded by each group are given below.



RESULTS

Filter	Freq. Transmitted ($\times 10^{14}$ Hz)	Stopping Voltages (V)	
		Group I	Group II
1	ALL	1.88	1.73
2	8.2	1.45	1.35
3	6.8	0.91	0.74
4	6.0	0.42	0.38

(1 mark) **a.** The DEPENDENT variable in this experiment is _____

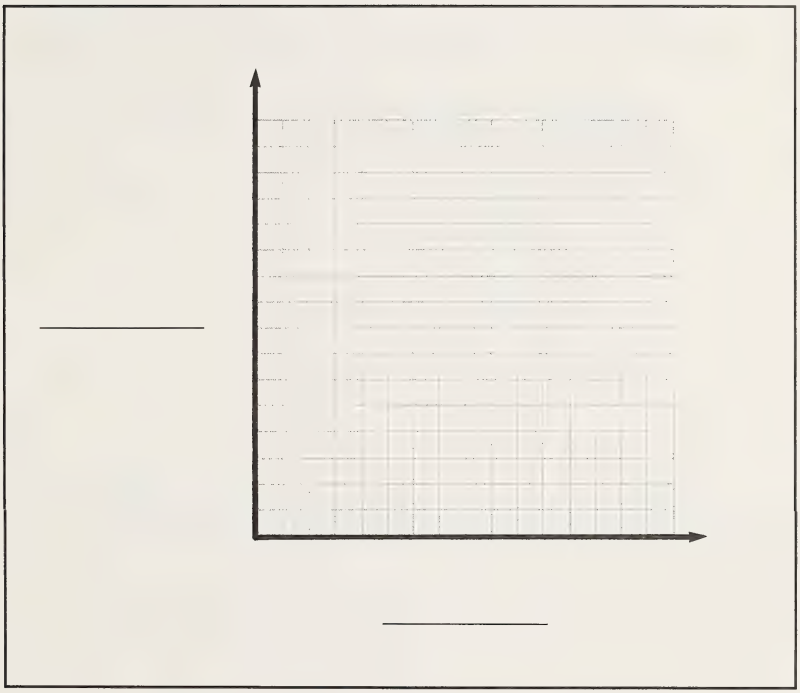
_____ .

(1 mark) **b.** The INDEPENDENT variable in this experiment is _____

_____ .

(USE FOR ROUGH WORK ONLY)

(3 marks) **c.** On the graph provided, plot the frequency transmitted and the maximum E_k of emitted photoelectrons. Be sure to label both axes. NOTE: Plot the data for Groups I and II separately.



(2 marks) **d.** From the graph of Group II's data, determine the value of Planck's constant, h. Show ALL your calculations.

(1 mark) **e.** What is the percentage error between the value obtained in ''d'' and the actual value of Planck's constant? NOTE: If you were unable to determine a value for Planck's constant, use $h = 7.0 \times 10^{-34}$ J•s for your calculation here.

(USE FOR ROUGH WORK ONLY)

2. The following experiment was performed by a group of students.

The masses of several boxes containing identical items were determined. The boxes each had exactly the same mass. The number of items in any box was unknown.

The results of the experiment are given below.

Box Number	Mass of Box and Contents (g)
1	5.51
2	4.51
3	4.01
4	3.41
5	3.31
6	2.71
7	5.61
8	3.11
9	4.91
10	3.21

(1 mark) **a.** Without knowing the box mass or the number of items in any box, what may be inferred concerning the mass of a single item?

_____

_____

(1 mark) **b.** Name the historic experiment to which this experiment is related.

_____

_____

(1 mark) **c.** State the result of the historic experiment. _____

_____

_____

(USE FOR ROUGH WORK ONLY)

(4 marks) 3. An alpha particle travelling at a relativistic speed of 1.5×10^8 m/s enters a uniform magnetic field at an angle of 90.0° to the field. If the field has a flux density of 0.80 T, what is the radius of curvature for the path of the alpha particle? Give a written explanation for any formulas that you use. Show ALL your calculations and express your answer to the appropriate number of significant figures.

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

FOR DEPARTMENT USE ONLY

M1 M2 M3

FOR DEPARTMENT USE ONLY

(LAST NAME) (FIRST NAME)

NAME:

Y M D

DATE OF BIRTH: SEX:

SCHOOL CODE: SCHOOL: _____

CITY: _____

SIGNATURE: _____

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